botanical boys or the members of the School Natural History Society.

IN consequence of Mr. Bidwell's severe indisposition, he has been unable to prepare his paper on "Telegraphic Photography," announced to be read before the Applied Chemistry and Physic Section of the Society of Arts to-day, and the reading has, therefore, been unavoidably postponed.

TWO strong shocks of earthquake occurred at Chio on the night of May 20, bringing down several of the houses that remained standing after the late catastrophe.

ABOUT a year ago the Boston Society of Natural History celebrated its semi-centennial by a jubilee meeting, and decided to commemorate the event by publishing a memorial volume consisting of memoirs from those among its present associates, eminent in various departments, whose circumstances enabled them to contribute. The New York *Nation* now announces the publication of the volume, a magnificent 4to of 600 pages, with 50 plates.

AT a meeting of the Sanitary Institute of Great Britain, held on May 18, Dr. B. W. Richardson, F.R.S., in the chair, the discussion was continued upon the address given by the chairman, entitled "Suggestions for the Management of Cases of Small-Pox and Infectious Diseases in the Metropolis and Large Towns." Mr. Pearson Hill gave a number of facts relating to the Hampstead Small-Pox Hospital, and a letter was read from Dr. Tripe giving statistics relating to the hospital at Hackney. Dr. W. H. Corfield, Dr. Willoughby, Mr. Hempson Denham, and Mr. Bridgwater also took part in the discussion.

A TRAPPER who recently arrived with musk-rat skins at Kingston, Ontario, delared, according to the *Colonies*, that the animal is becoming rapidly extinct.

THE telephone is being introduced by the New Zealand Government into places where the telegraph does not exist. Between Collingwood and Motucka, a distance of fifty miles, a line has been opened, and is said to work admirably.

THE work of the International Electrical Exhibition Commission is progressing, spaces having been allotted to the several countries on the ground-floor of the central transept. Meanwhile the general arrangement of the first floor has been decided upon. A saloon has been reserved for the Brush light and machines, and another for the Sawyer incandescent light. Mr. Edison will have a special saloon for his inventions. M. Maisme's incandescent light will be employed in lighting a saloon. The Jamin, Jablockhoff, Werdermann, and some others will each have its saloon. One of these is to be lighted by Tommassi voltaic elements.

IT is announced from Nanaimo that further important discoveries of coal have been made in Vancouver Island.

IT is believed in New Zealand that petroleum exists in large quantities in the North Island, and two companies are now engaged in sinking for it.

THE additions to the Zoological Society's Gardens during the past week include an African Cheetah (*Felis jubata*), a Secretary Vulture (*Serpentarius reptilivorus*) from Africa, presented by Mr. James S. Jameson; a Plantain Squirrel (*Sciurus plantani*) from Java, a Chipping Squirrel (*Tamias striatus*) from North America, presented by Mr. W. Bassano; a Ceylonese Hawk-Eagle (*Spizaetus ceylonensis*) from Ceylon, presented by Mr. G. Lyon Bennett; a Loggerhead Turtle (*Thalassochelys caouana*) from the Atlantic Ocean, presented by the Earl Brownlow; three Bull Frogs (*Rana mugiens*), a Noisy Frog (*Rana clamata*) from Nova Scotia, presented by Mr. Hugo Müller; two Green Lizards (*Lacerta viridis*), European, received in exchange; a Crested Guinea Fowl (*Numida cristata*), a Long-nosed Crocodile (*Crocodilus cataphractus*) from West Africa, on approval; six Speckled Terrapins (*Clemmys guttata*), two Painted Terrapins (*Clemmys picta*) from North America, purchased; an Eland (*Oreas canna*), an Axis Deer (*Cervus axis*), born in the Gardens; three Spotted-billed Ducks (*Anas pœcilorhyncha*), bred in the Gardens.

## GEOGRAPHICAL NOTES

THE anniversary meeting of the Geographical Society was held on Monday last, Lord Aberdare, the President, occupying the chair. Mr. Markham read the report of the Council for the past year, which showed that, though the number of Fellows had not materially increased, the Society was in a satisfactory and prosperous condition, its assets being valued at close upon 40,000*l.*, exclusive of the map collection and library. After a reference to publications it was stated that an observatory which had been built and fitted up at the Society's house had been in constant use by students and others who wished to practise observing or to get their instruments adjusted. The large map of Eastern Equatorial Africa by Mr. Ravenstein was said to be approaching completion, but the rate of progress is seemingly slow, as only three out of twenty-four sheets are reported to be printed off. Catalogues of the library and map-collection are in various stages of preparation. The presentation of medals afterwards took place, when Capt. de Fonseca Vaz, naval attaché of the Portuguese Legation, received the Founder's for Major Serpa Pinto, acknowledging the honour in a very happy speech, in which allusion was made to his own geographical work on the Zambesi. Mr. C. R. Markham received the Patron's medal on behalf of Mr. Leigh Smith, who is at Peterhead, preparing for another voyage to Franz-Josef Land. The Schools' prize medals were afterwards distributed among the boys from the City of London School and Dulwich and London International Colleges, whose names we gave in a recent issue. Mr. Francis Galton announced some changes in future examinations, adding that Australia has been chosen as the special subject for 1881-2. The ballot having been taken for the new Council, Lord Aberdare was re-elected President, and Mr. R. H. Major was elected a Vice-President in the place of the Hydrographer of the Admiralty, and Mr. D. W. Freshfield and Lord Reay respectively Secretary and Foreign Secretary in the places of Mr. Major and Lord Arthur Russell. Among the new members of Council are Col. Grant, Gen. Pitt-Rivers, and Col. Yule. Lord Aberdare lastly read a short address, in which he gave an interesting retrospect of the geographical work of the past year. The usual dinner was held in the evening, when the principal speakers, besides Lord Aberdare, were Count Münster, Lord Houghton, and the American Minister.

THE French, like the Italians, intend to explore the depths of the Mediterranean this summer; the Minister of Marine has decided to place the *Travailleur* at the disposal of a commission charged with the work of deep-sea exploration. The vessel will set out for the Mediterranean about the end of June.

THE following explorations will be made during this summer by the Russian Mineralogical Society:—In the province of Kostroma, for the completion of a geologicacal map of the province, by M. Nikitin; the exploration of the Tertiary and Chalk formations in the province of Bessarabia, by Prof. Sintzoff; in the Polish province of Lublin, in continuation of the researches of the late Prof. Barbot-de-Marny; the examination of the relations between the old and the new Caspian formations in the province of Astrakhan, in the Bistchi and Djaksy-Sassyk Mountains.

THE *Zeitschrift* of the Berlin Geographical Society, No. 92, contains the conclusion of Herr Niederlein's paper "On the Scientific Results of an Argentine Expedition to the Rio Negro"; "Travels and Topographical Surveys in the North Chinese Province of Chi-li," by Dr. v. Mollendorff, with two maps; an interesting extract from a Hawaiian manuscript, by Dr. Ad. Bastian, and varieties from Australia, by Herr H. Greffrath. In the *Verhandlungen* of the same Society are papers: "On the Maories of New Zealand," by Dr. Beheim-Schwarzbach; "On Ice-caves and Abnormal Ice-formations," by Prof. Schwalbe; and "On the South Carpathians," by Dr. Paul Lehmann.

AT a recent meeting of the Bengal Asiatic Society, Mr. F. A. de Roepstorff read some interesting notes on the in-

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habitants of the Nicobar Islands, a subject to which he has paid much attention. As the result of his visit and investigations last year he concludes that there is an element of Papuan origin among the people of the interior, and that this is strongly mixed with another not curly-haired race. It is true, then, as has been suggested, that there is a curly-haired race in the interior of Great Nicobar, but whether the Andaman Negrito and this tribe are related is very doubtful. Mr. Roepstorff hopes that future researches may enable him to settle the matter.

It is asserted in Algiers that a letter from Itarem, Chief of the Hoggar Tuaregs, has been intercepted, taking credit to himself for the massacre of Col. Flatters' expedition. This is the man who sent two of his relatives to Col. Flatters as a sign of goodwill, with which that officer professed himself so well satisfied.

The *Times* correspondent states that it is announced by Dr. Nachtigal that the first diet of German geographers will be held at Berlin on June 7 and 8.

## *ON DISCONTINUOUS PHOSPHORESCENT SPECTRA IN HIGH VACUA*[1]

IN a paper which I had the honour of presenting to the Royal Society in March, 1879,[2] I drew attention to the fact that many substances when in high vacua and submitted to the molecular discharge by means of an induction coil, emitted phosphorescent light; and I especially mentioned the phosphorescent sulphides, the diamond, the ruby, and various other forms of alumina, crystalline and amorphous.

Pure alumina chemically prepared has very strong phosphorescence. Sulphate of alumina is dissolved in water, and to it is added an excess of solution of ammonia. The precipitated hydrate of alumina is filtered, washed, ignited, and tested in the molecular stream. It phosphoresces of the same crimson colour, and gives the same spectrum as the ruby.

Alumina in the form of ruby glows with a full rich red colour, and when examined in the spectroscope the emitted light is seen to be discontinuous. There is a faint continuous spectrum ending in the red somewhere near the line B; then a black space, and next an intensely brilliant and sharp red line, to which nearly the whole of the intensity of the coloured glow is due. The wave-length of this red line, which appears characteristic of this form of alumina is, as near as I can measure, λ 689·5 m.m.m. This line coincides with the one described by E. Becquerel as being the most brilliant of the lines in the spectrum of the light of alumina in its various forms, when glowing in the phosphoroscope.

This coincidence is of considerable interest, as it shows a relation between the action of molecular impact and of sunlight in producing luminosity. The phosphorescence induced in a crystal of ruby by the molecular discharge is not superficial, but the light comes from the interior of the crystal, and is profoundly modified according as its direction of vibration corresponds or makes an angle with the axis of the crystal, being quenched in certain directions by a Nicol prism.

Sunlight falling on the ruby crystal produces the same optical phenomena. The light is internally emitted, and on analysis by a prism is seen to consist essentially of the one brilliant crimson line, λ 689·5. This fact may account for the extraordinary brilliancy of the ruby, which makes it so highly prized as a gem. The sun not merely renders the red-coloured stone visible, as it would a piece of coral, but it excites the crystal to phosphorescence, and causes it to glow with a luminous internal light, the energy of which is not diffused over a broad portion of the spectrum, but is chiefly concentrated into one wave-length.

The crimson glow of alumina remains visible some time after the current ceases to pass. When the residual glow has ceased, it can be revived by heating slightly with a spirit-lamp.

After long experimenting with chemically pure alumina precipitated from the sulphate as above described, a curious phenomenon takes place. When sealed up in the vacuum two years ago it was snow white; but after being frequently submitted to the molecular discharge for the purpose of exhibiting its brilliant phosphorescence, it gradually assumes a pink tinge, and on examination in sunlight a trace of the alumina line can be detected. The repeated molecular excitation is slowly causing the amorphous powder to assume a crystalline form.

Under some circumstances alumina glows with a green colour. Ammonia in large excess was added to a dilute solution of alum. The strong ammoniacal solution filtered from the precipitated alumina was now boiled. The alumina which the excess of ammonia had dissolved was thereby precipitated. This was filtered off, ignited, and tested in the molecular discharge. It gave no red light whatever, but phosphoresced of a pale green, and on examination with a prism the light showed no lines, but only a concentration of light in the green.

Two earthen crucibles were tightly packed, the one with sulphate of alumina, the other with acetate of alumina. They were then exposed, side by side, to the most intense heat of a wind furnace—a heat little short of the melting-point of platinum.[1] The resulting aluminas were then tested in the molecular stream.

The alumina from the sulphate gave the crimson glow and spectrum line.

The alumina from the acetate gave no red glow or line, but a pale green phosphorescence.

In my examination of rubies, many pounds of which have passed through my apparatus, I have been fortunate enough to meet with one solitary crystal, not to the eye different from others, which emits a *green* light when tested in the molecular stream. All others act as I may call normally. The spectrum of this green-glowing crystal shows, however, a trace of the red line, and on keeping the discharge acting on it for a few minutes the green phosphorescence grows fainter and a red tinge is developed, the spectrum line in the red becoming more distinct.

Besides the ruby, other native forms of crystallised alumina phosphoresce. Thus corundum glows with a pink colour. The sapphire appears to be made up of the red-glow and the green-glow alumina. Some fine crystals of sapphire shine with alternate bands of red and green, arranged in layers perpendicular to the axis. Unfortunately it is impossible to prepare a tube for exhibition containing this variety of sapphire, as it is constantly evolving gas from the numerous fissures and cavities which abound in this mineral.

The red glow of alumina is chiefly characteristic of this earth in a free state. Few of its compounds, except Spinel (aluminate of magnesium), either natural or artificial, show it in any marked degree. All the artificially crystallised aluminas give a strong red glow and spectrum line. An artificially crystallised aluminium and barium fluoride phosphoresces with a blue colour, but shows the red alumina line in the spectrum. Spinel glows red, and gives the red line almost as strong as the ruby.

The mineral Spodumene (an aluminium and lithium silicate) phosphoresces very brilliantly with a rich golden yellow colour, but shows no spectrum line, only a strong concentration of light in the orange and yellow. A phosphorescing crystal of Spodumene has all the internal light cut off with a Nicol prism, when the long axes of the Nicol and the crystal are parallel.

It became of interest to see if the other earths would show phosphorescent properties similar to those of alumina, and especially if any of them would give a discontinuous spectrum; considerable interest attaching to a solid body whose molecules vibrate in a few directions only, giving rise to spectrum lines or bands on a dark background.

Glucina, prepared with great care, is found to phosphoresce with a bright blue colour, but no lines can be detected in the spectrum, only a concentration of light in the blue.

The rare mineral phenakite (aluminate of glucinum), sometimes used as a gem, phosphoresces blue like pure glucina, no trace of the alumina line being found in its spectrum. This mineral shows a residual glow after the current is turned off.

Thorina has very little, if any phosphorescence. This earth is however remarkable for its very strong attraction for the residual gas in the vacuum tube. On putting thorina in a tube furnished with well-insulated poles whose ends are about a millimetre apart in the centre, and heating strongly during exhaustion, the earth on cooling absorbs the residual gas with such avidity that the tube becomes non-conducting, the spark preferring to pass several inches in air rather than strike across the space of a millimetre separating the two poles. It is probable that this strong attraction for gas is connected with the great density of the earth thorina (sp. gr. = 9·4).

Zirconia gives a very brilliant phosphorescence, approaching

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[1] Paper read before the Royal Society, May 19, by William Crookes, F.R.S.

[2] *Phil. Trans.* Part 2, 1879, p. 660.

[1] This operation was kindly performed for me by Messrs. Johnson and Matthey.

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